Final Report

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ROSAT Guest Investigator Program (AO-4)

Is GD 356 the First Known White Dwarf with Coronal X-Ray Emission ?

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OBSERVATIONS AND DATA ANALYSIS

We have suggested that cool and purely hydrogen magnetic white dwarfs may be sources of X-ray coronal emission and three prominent candidates for this emission (GD 90, KUV 2316-123 and GD 356) were observed during the second (AO-2) phase of ROSAT pointed observations. After these observations, we analyzed the obtained data and found an inconlusive (2σ) detection for GD 356. This looked very promissing, so we proposed to observe GD 356 by ROSAT with 25,000 s of the exposure time. The observations were approved for the AO-4 phase and the data were taken. We have received the tapes with the data and have analyzed the data at NASA/MSFC and at the ROSAT Science Center at NASA/GSFC. The data show no significant emission for GD 356. We derived upper limits for the X-ray luminosities by using a source code obtained from Dr. Schlegel. The

PIMMS software package was used to convert the upper limits on detector count rates to upper limits on L_x, the stars' luminosities in the PSPC 0.1 - 2.4 keV bandwidth. The calculation used a thermal bremsstrahlung emission model and an assumed temperature $T = 2.5 \times 10^6$ K. The derived upper limits for the X-ray luminosities provide constraints for a revision of current theories of the generation of non-radiative energy in white dwarfs.

A paper presenting the results of our analysis and entitled *ROSAT Pointed Observations of Cool Magnetic White Dwarfs* by Z. E. Musielak, J. G. Porter and J. M. Davis has been accepted for publication in *The Astrophysical Journal Letters*. Another paper dealing with theoretical implications of our results will be submitted to *The Astrophysical Journal*.

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The purpose of the subcontract was to permit final theoretical analysis of the potential for single, cool, magnetic white dwarfs to possess coronae sufficiently hot and dense to emit detectable X-rays. ROSAT searches by this and other groups under AO-1, 2 and 4 have yielded no convincing detections, even of the most promising stars, with very strong fields and some chromospheric lines in emission. Such coronae were expected because the stars in question have both convective surfaces (as evidenced by their temperature and by the mixing of carbon from their interiors upward) and strong magnetic fields, the combination responsible for activity and X-ray emission in less dense stars. The flaw seems to be that, in the strong gravitational fields of white dwarfs, coronae must be very dense. This results in a very short recombination time, so that only a very small amount of gas is ionized and hot at any given instant.

Meanwhile, another group has found coronal emission of X-rays from one single WD, KDD 005+5106 (T.A. Fleming et al. ApJ 416, L79, 1994). It is a very hot star, in fact the hottest helium-atmosphere white dwarf known (K. Werner A&A 284, 907, 1994) at roughly 10^5 K. Normal stars in this temperature range are also known to be ROSAT sources.

The sadly negative results of this investigation have been reported in colloquia by the project director at the Institute of Astronomy, Cambridge, American Association of Variable Star Observers, and University of California, Irvine, as well, briefly, in a review article to appear in the January, 1995 issue of Publications of the Astronomical Society of the Pacific.

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